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**CENTRAL INTELLIGENCE AGENCY
WASHINGTON, D.C. 20505**

2 October 1974

1505
MEMORANDUM FOR: The Director of Central Intelligence
SUBJECT : MILITARY THOUGHT (USSR): Protection of Electronic
Equipment from Nuclear Weapons Effects

1. The enclosed Intelligence Information Special Report is part of a series now in preparation based on the SECRET USSR Ministry of Defense publication Collection of Articles of the Journal 'Military Thought'. This article states that the equipping of enemy forces with more advanced nuclear munitions necessitates increasing the radiation resistance of communications means and radioelectronic components of armaments. Conditions which are most characteristic of the combat utilization of such equipment are examined in an effort to ascertain the degree of need for protection and the best methods for providing it. A table and graph illustrate the radii of the zones within which radioelectronic armaments will be put out of action by the shockwave and the neutron flux. The article appeared in Issue 1 (86) for 1969. 50X1-HUM

2. Because the source of this report is extremely sensitive, this document should be handled on a strict need-to-know basis within recipient agencies. For ease of reference, reports from this publication have been assigned the [] Codeword []

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David H. Blee
Acting Deputy Director for Operations

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Intelligence Information Special Report

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COUNTRY USSR

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DATE OF
INFO. Early 1969

DATE 2 October 1974

SUBJECT

MILITARY THOUGHT (USSR): Protection of Electronic Equipment from Nuclear Weapons Effects

SOURCE Documentary

Summary:

The following report is a translation from Russian of an article which appeared in Issue No. 1 (86) for 1969 of the SECRET USSR Ministry of Defense publication Collection of Articles of the Journal 'Military Thought'. The author of this article is Engineer Lieutenant-Colonel V. Barkov. This article states that the equipping of enemy forces with more advanced nuclear munitions necessitates increasing the radiation resistance of communications means and radioelectronic components of armaments. Conditions which are most characteristic of the combat utilization of such equipment are examined in an effort to ascertain the degree of need for protection and the best methods for providing it. A table and graph illustrate the radii of the zones within which radioelectronic armaments will be put out of action by the shockwave and the neutron flux.

End of SummaryComment:

The SECRET version of Military Thought was published three times annually and was distributed down to the level of division commander. It reportedly ceased publication at the end of 1970.

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Increasing the Radiation Resistance of Ground Communications
Means and Electronic Components of Armament

by
Engineer Lieutenant Colonel V. Barkov

The extensive and ever-increasing equipping of the forces of our probable enemy with nuclear munitions of various types and yields (including extremely low), as well as the tendency toward the creation of nuclear weapons comprising several warheads with a high overall capability of destroying objectives, compel us to turn our attention to the change in the correlation of the distances of destruction of ground communications means and radioelectronic components of armament from the shockwave and the penetrating radiation of a nuclear burst.

Requirements of a mechanical and climatological nature were taken into account in developing the military radioelectronic equipment which is currently in use in the armed forces, but no consideration was given to its resistance to the effects of penetrating radiation from a nuclear burst.

The equipping of the US Army with nuclear munitions having a TNT equivalent of 0.02 kiloton and more necessitates increasing the radiation resistance of communications means and radioelectronic components of armament against weapons using such munitions. This must be done in such a way that the operating viability and basic parameters of the equipment remain within their norms after exposure to penetrating radiation from a nuclear burst in all instances in which mechanical damage does not affect the electrical and structural components of the system and cause it to fail.

It is known that with a change in the yield of nuclear charges, there is also a change in the radii of the destruction zones from a shockwave and the penetrating radiation. Thus, if the nuclear bursts have a yield of less than one kiloton, the radii of the zones within which combat equipment and armament are put out of action by the shockwave are reduced more rapidly than if the bursts are of high yield, since the duration of the shockwave front will be less with bursts of low yield and the objectives will withstand strong overpressures.

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The yield of a burst will also affect the correlation between gamma radiation and the energy of the penetrating radiation emitted in the form of a neutron flux. For example, with a burst having a yield of 0.1 kiloton and at a distance from ground zero such that the total dose of radiation received equals 100 to 400 roentgens, approximately 63 percent of the energy of the penetrating radiation will be emitted in the form of neutron flux, while only 10 percent will be emitted in this form if the burst has a yield of 100 kilotons; 90 percent will be emitted in the form of gamma radiation.

Thus, as the burst yield diminishes, there will be a decrease in the radius of the zone within which objectives with radioelectronic means are put out of action by the shockwave, but there will be an increase in the radius of the permissible neutron flux zone and the effect of penetrating radiation will take on decisive significance among the remaining destructive factors of the nuclear burst.

Let us examine the conditions which are most characteristic of the combat utilization of ground communications means and electronic components of armament, those conditions under which they may be subjected to the effects of a nuclear burst.

At the control posts and communications centers of operational formations and large units deployed in the army and front rear services area, these communications means and components of armament will, as a rule, be located in previously prepared shelters, either temporary or permanent. We must expect such installations to be subjected to the effects of nuclear munitions of 50 kilotons and more, the main destructive factor being the shockwave. The mobile communications means and electronic equipment used at these installations are placed in shelters of the dugout type, which decreases the destructive zone by a factor of only 1.3 to 1.5. ✓

At stationary installations and in shelters for missile systems, considerable attention must be given not only to increasing the strength of the structures but also to protecting the components and materials used in control equipment, onboard missile systems, and electronic launching equipment, from the effects of the penetrating radiation of a nuclear burst.

At the tactical control level, portable and transportable small-sized communications means and electronic components are employed extensively in armament, tanks, armored personnel carriers, etc. The mobile nature of ✓

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combat activity explains the fact that communications means are on the move as much as half of the time. Because of their proximity to the front line, it will most probably be nuclear weapons with a yield of 10 kilotons or less which will be used against these objectives; in this case, the radius of the zone within which radioelectronic means are put out of action by penetrating radiation will be greater than the radius of the zone within which they are put out of action by the shockwave.

Naturally, the equipment placed in mechanically more durable structures and installations should also be more radiation resistant or should have special protection against penetrating radiation. For fixed installations this is achieved by creating screening structures of reinforced concrete, dirt, and other materials. Mobile installations, however, require other, special methods for increasing the protection of radioelectronic equipment.

Penetrating radiation, comprising mainly gamma radiation and a neutron flux, does not affect all electronic components simultaneously or in the same way. Gamma radiation, propagating with the speed of light, interacts primarily with the electron shells of matter and causes temporary, reversible processes in semiconducting and gas-filled devices, resistors, electrolytic condensers, and other components of equipment. In this case, the operating viability of the equipment is restored a few milliseconds after the burst. The neutron flux, however, which is delayed by the surrounding medium, propagates somewhat more slowly than the gamma radiation. It acts on the nuclei of the matter in equipment components and causes irreversible changes in the electrical characteristics.

At the present time, the radiation resistance, against neutron flux, of the communications means and the radioelectronic equipment of ground armament which have semiconductor components is not more than 10^{11} to 10^{12} neutrons/cm²; and if they are subjected to such a neutron flux, there may be interruptions the moment radiation takes place. Operation without interruptions or distortions can be guaranteed only with a neutron flux on the order of 10^{10} to 10^{11} neutrons/cm². The limit of resistance to the effects of gamma radiation does not exceed 10^6 to 10^7 roentgens per second.

For convenience in comparing the radii of the zones within which radioelectronic armament will be put out of action by the shockwave and the neutron flux (as the form of penetrating radiation from a surface nuclear burst which is most dangerous for radioelectronic means), let us examine the data set forth in the table and the graph.

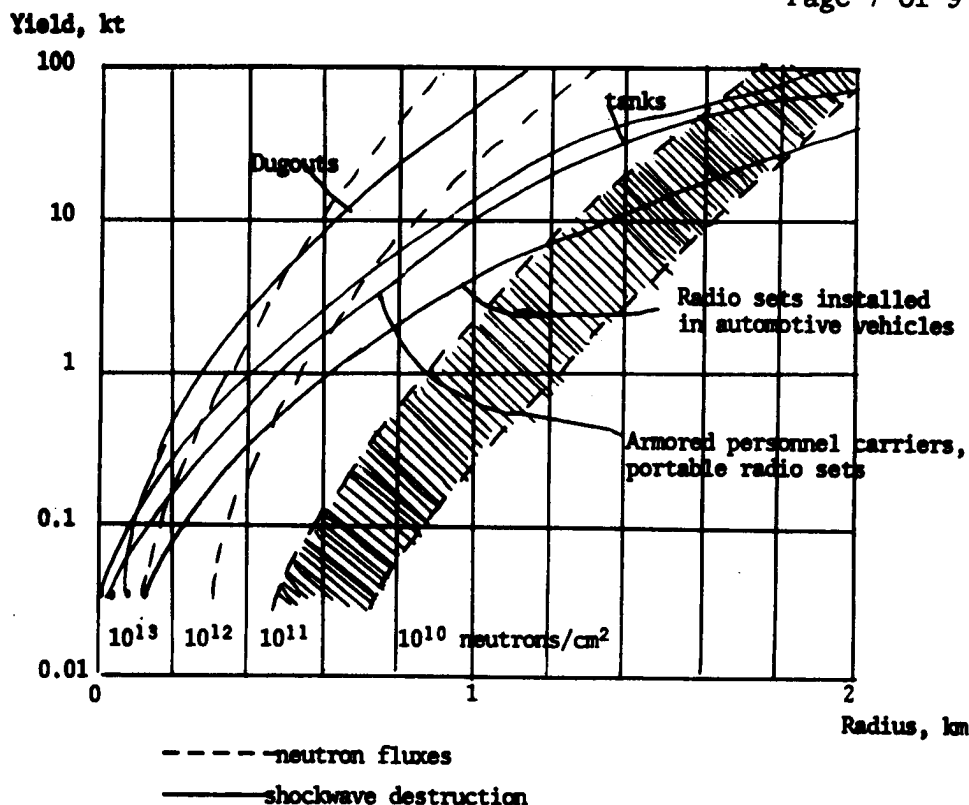
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Radii of shockwave destruction zones and radii zones
with neutron fluxes of 10^{10} to 10^{13} neutrons/cm²

TABLE

Yield of burst, kt	Radius of shockwave destruction zone, km				Radius of zone with total neutron flux, km			
	Heavy and medium tanks	Armored person- nel carriers, portable radio sets	Radio sets in automo- tive vehi- cles	Dug- outs	If flux per cm ² is:			
					10^{10}	10^{11}	10^{12}	10^{13}
0.1	0.06	0.1	0.24	0.1	0.85	0.55	0.36	0.2
1	0.4	0.45	0.6	0.27	1.25	0.86	0.56	0.34
10	0.86	0.97	1.3	0.58	1.6	1.25	0.86	0.58
100	1.85	2.1	2.8	1.25	2.1	1.65	1.25	0.9

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It may be seen from the table that in a burst with a nuclear charge of 100 kilotons yield or greater, the radius of the zone within which the shockwave will put mobile means out of action will exceed the radii of the zones of permissible neutron flux (10^{11} to 10^{12} neutrons/cm²), i. e., armament will be put out of action by the shockwave.

With a nuclear burst of 10 kilotons yield, the radii of the destruction zones of the shockwave and the penetrating radiation will be approximately equal. However, interruptions in the operation of radioelectronic equipment will be observed over large distances at the moment of the burst (when there is a flux of 10^{10} to 10^{11} neutrons/cm²). With a burst of one kiloton or less, however, the neutron flux will damage the electronic equipment in tanks and armored personnel carriers, and installations in automotive vehicles, at distances appreciably exceeding the damage from the shockwave.

A further reduction of the yield of nuclear warheads, for example, down to 0.1 kiloton, will cause a threefold increase in the radius of the zone of destruction from penetrating radiation in comparison with the radius of the zone of destruction from the shockwave. Interruptions in the operation of radioelectronic equipment will be observed over distances 5 to 10 times greater.

The data set forth here confirm that in order to guarantee the operating viability of the radiocommunications means and electronic equipment of armament under conditions in which the enemy employs nuclear weapons of extremely low yields, it will be necessary to increase the radiation resistance of portable communications means and electronic equipment installed in tanks and armored personnel carriers to withstand at least 10^{13} neutrons/cm², and that of installations in automotive vehicles to withstand 10^{12} neutrons/cm². If this is done, armament will be equally stable and will achieve uninterrupted operation.

Until the introduction into our forces of communications means with a radiation resistance one to two times greater than that of present means, measures must be taken for their protection by improving the conditions of their operation in the field. First of all, an effort must be made to place these means deep in the ground, since even partial recessing of installations will provide protection against neutron fluxes traveling at low angles to the ground. Small-sized communications means must be placed in dugouts and shelters at the earliest opportunity (at halts during a march, pauses during an advance or defensive operations, etc. and brought to the surface only when operating during combat. When small-sized radio

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communications means are placed in shelters they must be equipped with antenna extensions of coaxial cable (similar to those attached to R-105M or R-123 radio sets when they are operated in tanks) or other devices not having radioelectronic components. In order to conduct listening watches with radio sets installed in shelters, it is advisable to employ low-angle traveling-wave antennas of standard issue.

It should be kept in mind that with bursts of small-yield nuclear munitions, the radii of the destruction zones of the shockwave are virtually the same for dugouts, tanks, and armored personnel carriers, although armored personnel carriers offer no protection against the neutron flux, and tanks only weaken it by a factor no greater than 2. Breastworks provide the necessary protection for dugouts even if they are shallow. We can take as a rule of thumb that the neutron flux can be cut in half by armor with a thickness of 11 centimeters, wood of 10 centimeters, dirt of 9 centimeters, concrete of 8 centimeters, and polyethylene of 2.5 centimeters.

In order to increase the combat readiness of communications means and armament with electronic components under conditions in which nuclear weapons may be employed, it is necessary to improve methods for protecting personnel and radioelectronic equipment in units and large units, taking into account the actual conditions of their combat utilization.

We must work toward the creation of equipment with greater resistance to the effects of radiation, taking as a guide the parameters set forth above, and we must work out protective methods and the most effective ways of applying them.

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